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IS 15472 (2004): Guidelines for planning and design of low level outlets for evacuating storage reservoirs [WRD 10: Reservoirs and Lakes]



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“Knowledge is such a treasure which cannot be stolen”

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भारतीय मानक

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योजना और डिजाईन के लिए मार्गदर्शिका

Indian Standard

**GUIDELINES FOR PLANNING AND DESIGN OF
LOW LEVEL OUTLETS FOR EVACUATING
STORAGE RESERVOIRS**

ICS 93.16

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Spillways Including Energy Dissipators Sectional Committee had been approved by the Water Resources Division Council.

Evacuation outlets are provided in dams for depletion of reservoirs for inspection, maintenance and repairs and for controlling the reservoir pool rise during initial filling of reservoirs. These outlets need not necessarily be always located in the spillways. They can be located in the main dam or in the abutment also.

The composition of the technical committee responsible for the formulation of this standard is given in Annex A.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

GUIDELINES FOR PLANNING AND DESIGN OF LOW LEVEL OUTLETS FOR EVACUATING STORAGE RESERVOIRS

1 SCOPE

This standard provides general guidelines for planning and design of evacuation outlets for evacuating the reservoirs.

2 GENERAL PROVISIONS

2.1 It is desirable to provide low level outlets of adequate capacity in all dams for the following purposes:

- a) Evacuation of the reservoir to a specified elevation for inspection, maintenance and repairs; and
- b) Controlling the rate of reservoir pool rise during initial filling of the reservoir.

2.2 For lowering the water level of the reservoir for inspection and repairs when necessary, the requirement would be to evacuate a major portion of the reservoir in such time that after the water level is lowered, sufficient time is available for repairs before the water level rises due to higher inflows. For such a consideration, the outlets should be at the lowest possible level and of sufficient number, size and capacity to evacuate the reservoir taking into account the concurrent inflows.

2.3 The low level outlets should be located and sized to provide discharging capacity sufficient to evacuate the reservoir in a reasonable time and to maintain the reservoir filling rates as specified in the initial filling criteria for the project.

2.4 The drawdown levels and the evacuation time should be set forth for projects on a case to case basis. For structural safety, the reduction in height of water, which gives relief, is important. For very large reservoirs this may mean very large capacity outlets for speedy evacuation.

2.5 The initial reservoir elevation to be used for performing reservoir evacuation computations depends upon the reservoir storage allocations and project needs. Normally the full reservoir level (FRL) is selected as the initial reservoir level for reservoir evacuation studies.

2.6 The volume corresponding to the dead storage capacity of the reservoir is not to be considered for evacuation purposes.

2.7 Suitable inflows in the reservoir should be assumed while computing the period of evacuation and for initial filling of the reservoir as per the following guidelines.

2.7.1 *For Reservoir Evacuation*

Inflows into the reservoir for analysis purposes should be the highest consecutive mean monthly inflows for the duration of the evacuation period.

2.7.2 *For Initial Filling of the Reservoir*

Inflows for initial filling should be based on a combination of base flow and a frequency flood event. If the selected frequency flood includes base flow, average monthly stream flow should not be added to the hydrograph. Base flow should be the average of the mean monthly stream flow for the anticipated filling period. Generally the selected frequency flood will have a return period of five times the filling period with a minimum return period of 5 years.

2.8 All water release facilities, for example, gated spillways, sluices, outlet works, penstocks, etc, should be considered to be available for evacuation for supplementing the low level outlets to the extent that their reliability can be considered as reasonably certain.

2.9 For normal evacuation purposes, the drawdown rate should be limited to the safe downstream carrying capacity of the river. In case of canal outlets, there should be a positive means of making releases into a natural water course through a bypass or a wasteway as it is possible that there may not be any irrigation requirement at that time. In case of power plants, more than one unit must be installed and made operational. Generally only 50 percent of the release capability of the turbines should be considered available because some units could be inoperational when their discharge capacity is needed.

Other factors like possible adverse flow conditions/cavitation in case of simultaneous operation of both spillway and sluices, if they are located in the spillway blocks, should also be kept in view.

3 DESIGN REQUIREMENTS

3.1 Location and sizing of low level outlets should be done in a systematic way, considering the following aspects:

- a) Emergency evacuation requirements of the project,
- b) Possibility of taking advantage of the outlet work in routing the inflow design flood as a supplement to the spillway arrangements, and
- c) Initial filling requirement.

3.2 In our country, reservoir sedimentation is a potential problem. Normally the evacuation outlets should be located above the predicted 100 year silt elevation or else a multilevel intake structure should be provided to prevent the outlet works from being plugged by sediment load during the life of the project. Any deviation from the above aspects based on site specific factors can be considered on case to case basis.

3.3 Low level outlets can be provided both as sluices and as depletion tunnels. These can be located either in the main dam or in the spillway or in the abutments. However it is to be ensured that these do not get blocked due to any possible landslides in the reservoir. Suitable energy dissipation arrangements are required to be provided for energy dissipation at the exit.

4 EVACUATION TIME

4.1 Guidelines on this aspect should generally take into account assessment of hazard potential and risk potential of the dam. However, in the Indian conditions where population growth in downstream areas is not controllable, the hazard potential at the initial stage and its subsequent increase cannot be assessed. In most cases the dams would come under high hazard category.

Similarly risk is very difficult to classify because of various combinations of adverse conditions that may be involved at a particular dam site and the type of dam.

Classification is also recommended to be based on the height of dams so far as determination of risk potential is concerned and dams with a height of more than 50 m are to be considered more important than those of height less than 50 m.

For evacuating storage reservoirs and sizing low-level outlets, three categories are suggested as given in the table below. These assume a general balance between hazard and risk and could be adjusted on the basis of detailed site specific studies.

Evacuation Time (in Days)

Sl No.	Depth of Evacuation (from Initial Pool Level)	Degree of Hazard or Risk		
		High	Significant	Low
i)	25	20	30	50
ii)	50	40	50	70
iii)	75	80	90	100

The above evacuation periods would generally be within the overall requirement to drawdown the reservoir within a period of one to four months allowing sufficient time for carrying out inspection and repairs before the water level rises due to higher inflows of monsoon.

In some exceptional case, it may not be technically possible and economically feasible to provide the required drawdown capability to meet the above criteria because of the size of the project (unusually small or large) or because of some special feature. In such a case, the criteria regarding drawdown level or the evacuation time could be altered to suit the site specific case if the results of studies so indicate.

4.2 Site specific sequence of operations to be followed for evacuation needs to be planned for every project. In case of gated spillways, reservoir can be lowered from initial pool level which is generally the full reservoir level, to the spillway crest level by suitably opening the spillway gates taking cognizance of the downstream channel capacity. Further lowering of the reservoir could be through the low level and other outlets. Actual details are however required to be planned on case to case basis.

5 INITIAL FILLING OF RESERVOIRS

Initial reservoir filling is the first test of a dam to perform its intended functions. As the sizing of the outlet works to meet the probable outflow requirements during initial filling has to be fixed during designs, the information on the desired rates of pool rise must also be available at the time the design requirements are established.

In order to monitor reservoir performance, the rate of filling should be controlled to allow in accomplishing a predetermined monitoring program. Low level outlets should be located and sized to provide discharge capacity sufficient to maintain the reservoir filling rates specified by the initial filling criteria to hold reservoir levels reasonably constant for elevations above 50 percent of the hydraulic height of the dam. Inflows in the reservoir should be assumed as per 2.7.2.

Reservoir filling criteria are established on a dam to dam basis. In general the objective as already stated above is to provide a planned program with adequate time for monitoring and evaluating performance of the

dam and its foundation as the reservoir is being filled for the first time.

The major factors to be considered in establishing initial filling criteria are as under:

- a) Type of dam — Concrete, masonry, earth or rockfill.
- b) Geology of the dam foundation and reservoir area including seismicity and landslide potential along the banks of the reservoirs.
- c) Hazard potential.
- d) Inflow characteristics — Controlled or uncontrolled.
- e) Hydrology — Flood patterns and seasonal base flows.
- f) Release provisions for project requirements, flood release and emergency evacuation.
- g) Type of instrumentation and provision for monitoring, instrument response time and evaluation time needed.
- h) Safe channel capacities downstream of the dam.
- j) Characteristics of reservoir storage.
- k) Construction schedule.

Filling rates for concrete/masonry dams are much less restrictive than for embankment dams.

Site specific initial filling programs should be prepared based on the factors enumerated above. A general initial filling program in respect of embankment dams, which can be suitably modified as necessary, is as under:

- a) The first stage consists of filling the reservoir up to MDDL. This filling can be done without restraint as the hazard potential to the public and economic development downstream of the dam is low.
- b) The second stage consists of filling the reservoir from MDDL to the crest of spillway. For

earth and rockfill dams this stage filling should be done in two parts.

The reservoir above MDDL should be gradually built at a rate not exceeding 3 m per fortnight and filling should be temporarily stopped at half the height between MDDL and crest of spillway, for a reasonable time in order to assess the behaviour of the structure on the basis of observed values and to take a decision about further storage and remedial measures in case of distress.

After a decision is taken to continue the filling, further building up of the storage should be done in gradual sub-stages of 2 to 3 m per fortnight depending upon the height of the dam and increase in storage capacity. The reservoir should then be temporarily held at the crest level of the spillway for a reasonable time for monitoring and evaluating the performance of the dam and to take a decision about further storage.

- c) The third stage consists of filling above the crest of the spillway up to the full reservoir level (FRL).

The rate of reservoir filling above crest of spillway should be restricted to sub-stages of 0.3 m in 48 h. The reservoir should be temporarily held at half the height between FRL and crest of spillway for sufficient time for monitoring and evaluating performance of dam and to take a decision about further storage/remedial measures, if any.

5.1 The instrumentation program and frequency of taking observations during initial filling of the reservoir including the periods for which the reservoir is held constant at specified levels should also be finalised simultaneously for structural monitoring of the structure at that time. The structural behaviour reports should be prepared for each stage of filling.

ANNEX A
(Foreword)
COMMITTEE COMPOSITION

Spillways Including Energy Dissipators Sectional Committee, WRD 10

<i>Organisation</i>	<i>Representative(s)</i>
Sardar Sarovar Narmada Nigam Ltd, Gandhinagar Bhakra Beas Management Board, Nangal Township	SHRI N. B. DESAI (<i>Chairman</i>) SUPERINTENDING ENGINEER EXECUTIVE ENGINEER (<i>Alternate</i>)
Bodhi Water Resources Dept, Bhopal	SHRI J. K. TIWARI SHRI R. K. CHACHONDIA (<i>Alternate</i>)
Central Design Organization, Gandhinagar Central Water & Power Research Station, Pune	SUPERINTENDING ENGINEER SHRI P. B. DEOLALIKAR SHRIMATI V. V. BHOSEKAR (<i>Alternate</i>)
Central Water Commission, New Delhi	DIRECTOR [CMDD-N&W] DIRECTOR [SSD&C] (<i>Alternate</i>)
Consulting Engineering Services (I) Ltd, New Delhi	SHRI V. K. KAPUR SHRI P. K. SANGHI (<i>Alternate</i>)
Gujarat Engineering Research Institute, Vadodara	SHRI V. S. BRAHMABHATT RESEARCH OFFICER (<i>Alternate</i>)
Hindustan Construction Company Ltd, Mumbai	SHRI R. G. VARTAK SHRI K. R. VISHWANATH (<i>Alternate</i>)
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Irrigation Department, Govt of Andhra Pradesh, Hyderabad	CHIEF ENGINEER SUPERINTENDING ENGINEER (DAMS) (<i>Alternate</i>)
Irrigation & Water Ways Directorate, Govt of West Bengal, Dist Darjeeling	SUPERINTENDING ENGINEER EXECUTIVE ENGINEER (<i>Alternate</i>)
Irrigation Department, Govt of Orissa, Bhubaneswar	CHIEF ENGINEER (D&R) DIRECTOR [HEAD WORKS] (<i>Alternate</i>)
Irrigation Department, Govt of Punjab, Chandigarh	CHIEF ENGINEER (RSDD) DIRECTOR SPILLWAY (RSDD) (<i>Alternate</i>)
Irrigation Department, Govt of Uttaranchal, Roorkee	CHIEF ENGINEER & DIRECTOR SUPERINTENDING ENGINEER (<i>Alternate</i>)
Irrigation Department, Govt of Karnataka, Karnataka Irrigation Department, Govt of Maharashtra, Nashik	DIRECTOR SUPERINTENDING ENGINEER (MD) EXECUTIVE ENGINEER (MD-5) (<i>Alternate</i>)
Jaiprakash Industries Ltd, New Delhi	SHRI D. G. KADKADE SHRI NARENDRA SINGH (<i>Alternate</i>)
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Wapcos (India) Ltd, New Delhi	SHRI S. R. NARAYANAN SHRI A. P. CHOUDHARY (<i>Alternate</i>)
BIS Directorate General	SHRI S. S. SETHI, Director & Head (WRD) [Representing Director General (<i>Ex-officio</i>)]

Member-Secretary
SHRIMATI ROSY DHAWAN
Joint Director (WRD), BIS

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